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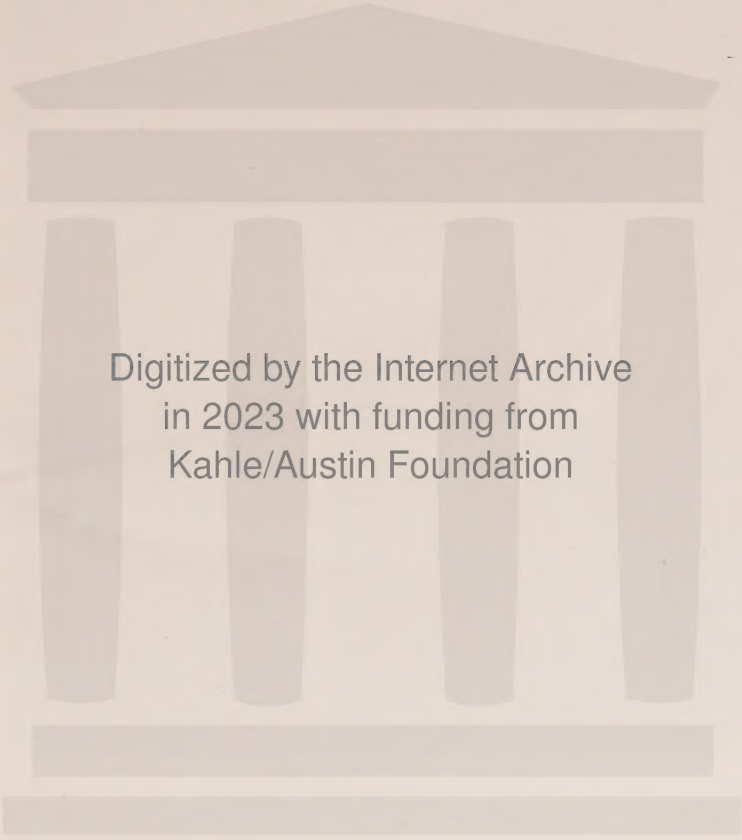

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PLATE 1197. Two plants of *T. dubius* showing relative sizes and characters. (A) Larger and more typical plant. (B) Smaller and less frequent plant.

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JOURNAL OF

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A NOMENCLATURAL NOTE IN THE GENUS TRAGOPOGON*

F. H. Montgomery

While examining specimens of the genus *Tragopogon* (Goatsbeard) occurring in Ontario, it was found that in the species with lemon-yellow ligules (*T. major* Jacq. in the recent edition of Gray's Manual, and *T. dubius* in the new Britton and Brown "Illustrated Flora" 1952) there was great variation in the size of the plants, the amount of branching, the size of the heads, and the number of involucral bracts. The plants varied from 15 to 76 cm. in height; some were single-stemmed, while others were almost bushy in character; the mature heads ranged from 2.5 to 7.5 cm. in diameter, and the number of involucral bracts varied from 8 to 13.

The question arose whether these were all *T. major* as described by Jacquin, whether some were *T. major* and others the *T. dubius* of Scopoli, whether the variations should be considered as sub-species of *T. dubius* as recognized by some European authors or whether they all should be classified simply as *T. dubius*. Shinners has argued for the use of *T. major* as the name for our species, but his inferences concerning the specific distinctness of the original *T. dubius* do not seem to be clearly established.

Recourse to Hegi's "Illustrierte Flora von Mittel–Europa" did not help to solve these difficulties. Hegi's description of *T. dubius* ssp. *major* and his fig. 732 do not agree, and the identity of the figure is doubtful. It is not similar to Jacquin's illustration of *T. major*, nor to the plants growing in this province which we believe to be similar to Jacquin's species. Furthermore, Hegi's

* This investigation was supported by the assistance of a grant from the Research Council of Ontario.

fig. 733a of *T. dubius* ssp. *dubius* illustrates the larger plants which are growing in Ontario (fig. 1a) and his fig. 733b is characteristic of the smaller plants (fig. 1b).

To clarify the nomenclature of the species and to determine the relationship, if any, between *T. dubius* Scop. and *T. major* Jacq., a review was made of the literature pertaining to the origin and use of the nomenclature by former authors. Also, information was assembled concerning the life history and ecology of the species to determine the effect of these on the nature of the plants. Considerable effort was made to obtain photographs of Scopoli's types, but after much correspondence with European herbaria, we were informed by Prof. R. Ciferri of the University of Pavia that most of Scopoli's types have been lost. It is realized, then, that the basic problem of the identity of Scopoli's *T. dubius* remains unsolved, and must remain so under these circumstances. The understanding of the species, therefore, must be based upon the interpretation of literature relating to this species.

Scopoli (1772) described *T. dubius* from material collected in the region of Trieste. From his brief description and an accompanying comparison with *T. pratensis*, the plant may be described as small, unbranched, somewhat flocculose, leaves flat, having no undulations on the margins and no curling of the tips of the blades; heads about 2.5 cm. in diameter; the ligules sulphur-colored and shorter than the involucral bracts.

In 1773, Jacquin, with greater detail, described and illustrated *T. major*. It did not differ essentially from *T. dubius* except for its greater size, its branching habit and larger heads.

For nearly 100 years European authors of floras used Jacquin's name *T. major* and placed *T. dubius* in synonymy. In 1859 Grenier stated that the specific name should be *T. dubius* because of the earlier publication of this name. Index Kewensis, 1895, reduced *T. major* to synonymy under *T. dubius* and in his "Flore de France," 1903, Coste used this nomenclature. About this time, botanists also began to take note of the two forms of the species and in 1908 Rouy, although retaining *T. major*, made a sub-species *dubius* to accommodate the smaller plants. *T. dubius* was taken up by Vollman, 1910, but in his "Flora von Bayern," 1914, he said only the ssp. *major* was

found in that area. This combination was followed by later German authors. Schinz and Thellung disagreed with Rouy that the smaller plants were a ssp. of *T. major*, and made the combination *T. dubius* ssp. *dubius*, and this nomenclature was included in the works of Schinz and Keller, and Hegi. From this literature review it would seem that *T. dubius* ssp. *major* was intended to cover large specimens of this species, and these seemed to be the more common in the areas covered by the floras: *T. dubius* ssp. *dubius* was used to indicate the smaller plants.

The species shows great plasticity, and this is particularly evident under varying environmental conditions. Where growing conditions are optimum, large vigorous plants are the most frequent; but where soil conditions are poor, or where normal growth is interrupted, e. g. by mowing of the roadsides, only depauperate plants occur. Where soil conditions are variable, as along road or railroad embankments, near gravel pits, or where only a part of a roadside is mowed, plants of both forms are to be found. Sometimes they may grade from extremely small plants to large plants.

Ownbey (personal correspondence) has found that the time of germination of the seeds is also a factor affecting plant characteristics. Seeds germinating in the spring may flower the same year, and the plants are annual and of the reduced type. If they germinate late in the season and survive the winter, they flower the following spring, but have not yet reached their greatest maturity and are therefore small in character. Ownbey has grown seeds of both large and small plants under similar conditions in experimental plots in the State of Washington, and the resulting offspring have been indistinguishable. In the absence of genetic factors that would cause the extreme variations that have been mentioned here, he is not inclined to assign taxonomic value to these differences.

From the literature reviewed, field studies, and genetical studies it appears that *T. dubius* Scop. and *T. major* Jacq. are identical, and that a separation into sub-species by Schinz and Keller, Hegi and others is unnecessary. Since *T. dubius* Scop. has priority, our lemon-yellow *Tragopogon* species should receive this name.

I wish to thank Dr. Reed C. Rollins, Director of the Gray Herbarium, and Dr. I. M. Johnston of the Arnold Arboretum for permission to use the library facilities of these institutions; Miss Marjorie Stone, Librarian of the Gray Herbarium for her generous assistance while working in the library; Dr. Marion Ownbey for reading the manuscript, and numerous helpful suggestions.—Department of Botany, Ontario Agricultural College, Guelph, Ontario.

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CHROMOSOME STUDIES IN KUHNIINAE (EUPATORIEAE). I. BRICKELLIA

L. O. Gaiser

(*Continued from p. 321*)

It is considered that there has been consistency in the effects of temperature on meiotic coiling (Swanson, 1942). He found that both high and low temperature caused a greater than normal contraction of chromosome length. We cannot explain what caused one cell of *B. glomerata* in a Feulgen preparation to contract as much as many resulting from pretreatment with paradichlorobenzene in *B. microphylla*. Both gave evidence of the possibility of contraction of the chromosome length normal to these species, by chemical means. Thus it may be that by genic action the same has been accomplished under natural

conditions in *Brickellia*. Like the influence of a gene or genes, it has been effective along several different lines and probably at different times, as in the xerophytic shrubs of the *Baccharideae*, the two perennials, *B. Rusbyi* and *B. floribunda*, and the restricted forms, *B. Greenei* and *B. incana*.

In *Crepis*, which is almost world wide in distribution, there are at least 40 annuals and 143 perennials with 13 variables. In that genus there is ample evidence of progressive reduction of plants going along with the change from perennials to annuals. And there is the same parallelism with reduced chromosome size. A glance at the chromosome figures of the frontispiece (Babcock, 1947) shows one karyotype and what could be a reduced replica of it, for a primitive and advanced species respectively. That author stated there was as yet no direct evidence of the cause of the reduction but that it might well depend upon gene mutations.

At present, less has been accumulated for *Brickellia* on a progressive adaptation to a more and more xerophytic environment and yet it is just in the species of that habitat that morphological changes of chromosomes have occurred.

If we consider the species having karyotypes representing an amount of chromatin which is less than that found in the majority of species, the group is found to include the one species, so well characterized by its name, *B. incana*, which is notably xerophytic and is of restricted distribution in southern California and Nevada, and *B. Greenei* also confined to a region of northern California and Oregon. No reference has been made to this species being xerophytic. The locality of the type specimen was along the south fork of the Scott River, Siskyou Co. and the specimen here studied was collected on the South Fork Indian Creek, in the Siskyou Mountains. Of the habitat, the collector, Dr. L. C. Wheeler, has written: "It was found on a hot dry flat, a few feet above and probably between one and two hundred feet from the living stream, on the north side of an easterly-westerly canyon. In sites of this sort at low elevations in the Siskyous (this was probably ca. 1500 ft. elevation) it becomes very hot and dry in summer. This habitat is far enough above and away from the main streams that it is disturbed by streamflow only in rare floods." This certainly grew in a xeric situation. There are also *B. desertorum*, the extremely xerophytic member of the sub-

section *Baccharideae*, of approximately the same range as *B. incana*, and the more widely distributed *B. californica* to which it is considered similar. With *B. laciniata* and *B. veronicaefolia* there are included four of the seven (the eighth considered elsewhere) of that subsection, described as more or less xerophytic. The only other subsection similarly characterized, which is represented in this study, is the *Microphyllae*, consisting of four species. While the three here included do not have karyotypes of the shortest chromosomes, they come next to this extreme. Then there are *B. Rusbyi* and *B. floribunda*, described as herbaceous somewhat shrubby perennials occurring in the Arizona and New Mexico Mountains. Among all these, there seems to be a considerable stress on their xerophytic nature, If we take the reduction in chromosome size seen in their karyotypes as evidence of their evolutionary position in the genus *Brickellia*, it might exemplify the hypothesis of Stebbins (1951) that "Environments limiting or deficient in one all important factor, moisture, have often promoted evolution." While no species of *Brickellia* is palustrine, among the more mesophytic ones examined, none have the complement of shorter chromosomes. That the one species having the longest chromosomes of all is found on low mountains of the plateaus may seem to contradict the hypothesis. However, with successful storage capacity in a fleshy rhizome, it may well represent a successful adaptation of a primitive form. It has been noticed in this connection that *B. monocephala* is among the very earliest to flower and mature. Before the rainy season had ended, in mid-August, this species was in bloom on the hills of El Salto and had some ripened seeds. When the collector* returned for more seeds, near the end of September, no plants could be found, partly because of the rich growth of later composites such as *Cosmos*. As a reason for rapid evolution in arid regions, Stebbins listed storage roots among the many specialized structures which plants have as adaptations for drier climates.

As Babcock (*l. c.*) has so ably pointed out, the goal is to coordinate the evidence from cytology with comparative morphology. Thus reëxamination of some morphological details may reveal discrepancies in taxonomic treatments.

* By private communication from Mr. D. B. Gold, Mexico City.

With regard to the achene, Robinson's attention was especially centered on the number of ribs, since with one marked exception (*B. Fendleri* Gray), this was constant for the genus. There was no discussion of the variation in size though it was included in the descriptions, with accompanying drawings, of all but twenty-two species. By supplementing the sizes of any others of which material has been available for these studies, five blanks could be filled (e. g., *B. brachyphylla*, 5 mm., *B. venosa*, 3 mm., *B. oliganthes*, 3.5 mm., *B. glomerata*, 3.7 mm., and *B. Rusbyi*, 3 mm.). Using only these figures, in addition to those of Robinson, several general observations come clearly into focus. The largest achene is that of *B. incana*, 10 mm., the second is *B. Greenei*, 7 mm., and the third is *B. monocephala*, 6 mm. Three species have achenes of 5.5 mm.: *B. argyrolepis*, *B. pendula* and *B. squarrosa* (Cav.) Robinson. Among the next with achenes of 5 mm. are *B. adenocarpa* and *B. grandiflora*. The shortest is *B. diffusa*, 1.7–2 mm. Two unstudied, narrow-leaved species come next. These are closely followed by *B. floribunda*, 2 mm. There are ten species of the size between 2 and 3 mm. of which *B. filipes*, the second annual, is shortest, 2.2 mm., and this is followed next by one unstudied species of the *Baccharideae*, *B. baccharidea* Gray, 2–2.3 mm., and *B. desertorum*, 2.3 mm. While five other species, scattered here and there through the genus follow, *B. laciniata*, 2.8 mm., *B. californica*, 3 mm., also of the *Baccharideae*, and *B. Rusbyi*, 3 mm., come next. The other forty-two species have values between 3 and 6 mm.

It is impossible to say that reduction of achene size is parallel to chromosome size in all of that group, for there are exceptions. But those studied which have the longest chromosomes are among those having the largest seeds with the exceptions of *B. incana* and *B. Greenei*. Those which have short chromosomes are with the same two exceptions, among those having very small fruits. Also, it is clear that *B. Rusbyi* and *B. floribunda* come close to the *Baccharideae* in yet another character.

There is agreement here with the findings in *Crepis* as is so strongly emphasized in the colored frontispiece (Babcock, *l. c.*) which shows two species, one a perennial and the other an annual, both having the same chromosome number 5. The former is the most primitive species with that complement and has a large

fruit. The latter and most advanced has a very much smaller one. A second pair of species (figs. A and B) are used similarly to illustrate many size differences which have become reduced in the line of advance. Of the annual, considered to be the most advanced in the genus, mention is made of "the remarkable longevity of the tiny achenes." This had been the unanticipated but much appreciated surprise in finding *B. diffusa* viable after five years, when the shrub from Costa Rica was much less so after five months and others from western United States at least after two years.

From the species studied, there has been a reduction in size of flower heads and the achene where a marked diminution of the chromosomes has been found, with the two exceptions *B. Greenei* and *B. incana*. To a considerable extent and with the same species excepted, the number of florets in the head have shown the same trend although with considerable overlapping. There is also evidence of reduction of the plant and its parts, especially in the extremes, when we compare the annual with a large woody shrub having a stem two inches in diameter, or its small fibrous root with the large strong roots of the same shrub or even the fleshy rhizomatous ones of others. Without a complete study of all species, comparative generalizations are out of order. However, there is at least strong similarity to these parallel phylogenetic changes stated for *Crepis* by Babcock (*l. c.*). Even for the exceptional *B. Greenei* and *B. incana* a parallel can be found in *Crepis* in the statement that a decrease in chromosome size was found to be associated with a specialized and restricted distribution of the species. The greatest points of difference are the progressive decrease in number and increase in asymmetry of chromosomes, with the least well marked trend in the diminution of the chromosomes in *Crepis*. Almost the converse holds in *Brickellia* with no change in their number and marked reduction in size. Lack of much evidence of an increase in asymmetry of their form may of course be due to the examination of an insufficient number of species. Satellites were found in three species. Recognizing that they are very small in *B. Greenei* and *B. incana*, they could have been missed and may possibly have been in some others. Yet the very successful and widespread annual, *B. diffusa*, which has attained the peak in this genus, has shown

no recognizable tendency in this direction. It may be, that lack of quite as many phylogenetic changes in the chromosomes of this smaller genus finds some explanation in its still comparatively limited distribution, occurring only in the new world and mainly the northern hemisphere, in contrast to the world wide distribution of *Crepis*.

Because the number of florets per head was considered to be fairly constant, Robinson used it successfully in conjunction with other characters, for the primary divisions of the genus. Thus he had separated section *Macrobrickellia* from *Eubrickellia* and the latter from *Bulbostylis* on the basis of larger heads. Separation of the latter, 28- to 62- rather than 20- to 26-flowered, he stated, both in the introduction as well as under the sectional heading, was one of less significance but of greater convenience for classification. To avoid errors in identification, one species, *B. grandiflora*, with 20 to 38 flowers per head, appears in the keys of both. Of significance in this relation is the fact that within one clearly defined species, *B. veronicaefolia* of section *Bulbostylis*, the number of florets may vary from 18 in variety *veronicaefolia* to 62 in *umbratilis*. With such an overlap in the number of florets per head in several individual species, it may be permissible to disregard boundaries between what appear to be specific affinities at other inter- and intra-sectional levels.

In several pairs of species, of which one was placed in each of the sections *Bulbostylis* and *Eubrickellia*, it was brought forcibly to my attention, perhaps more so as a result of examining trichomes and the cleared leaves on which they were observed, that one of the two approaches a somewhat smaller, or reduced example of the other. This was first recognized from seeing the strongly reticulate and unusual arcuate venation common to the coriaceous leaves of *B. cuspidata* and *B. lanata*. It was found that this greater prominence of the submarginal veins was due to sclerenchymatous walls surrounding the veins or veinlets. The almost glabrous leaf of the former with a short petiole is distinctive in having a cusp at its tip while the larger, longer-petiolate leaf of the latter is generally serrate with few sharply pointed teeth and is covered with long slender trichomes in the juvenile condition, becoming more or less glabrous later. However, as recognized in variety *microdonta* Robinson, the serrations may be

very shallow and mucronate and the leaf almost sessile. While not collecting a match for this variety, there were at one location near Guadalajara, a number of plants with characteristically broadly ovate leaves and of one plant they were petiolate yet practically without serrations. In the barranca, where *B. lanata II* was collected, the form of leaf was rather broadly lanceolate, much narrower than in any of the three other collections. Also, although only a few seeds of typical *B. cuspidata* were received from the collector in Guadalajara, small leaf samples of three plants had been sent earlier for purposes of identification, and of these, one shows a marked variation to a more dentate leaf with a less prominent terminal cusp. Thus the difference between the almost entire ovate leaf of *B. cuspidata*, as shown in figure 33 of Robinson, in subsection *Amplexicaules*, and the coarsely serrate one of typical *B. lanata* of figure 94 in *Eubrickellia* is lessened. As known at present, *B. cuspidata* is apparently more rare, and restricted to the vicinity of Guadalajara, while *B. lanata* is of wider distribution in Jalisco. However, there was a possible reason for our missing it in the collector's recent note that it is "so much smaller."

A second example can be quoted in the striking similarity of *B. amplexicaulis* of subsection *Amplexicaules* and *B. Wislizeni* of *Eubrickellia* with heads 13- to 22-flowered in the former and 50- to 60- in the latter. Modifications resulting under similar greenhouse conditions, gave smaller heads and left a much narrower gap between these two. Both have membranaceous leaves. Although those of *B. Wislizeni* were described as pubescent on both sides, the indumentum in this species is of glandular trichomes which are the longest found in the genus. Those of *B. amplexicaulis*, described as having hairs of inequal length above, and copiously pubescent below, more so on the basal veins, were found to have the same kind of glandular trichomes of a variety of lengths on the upper surface. The trichomes on the lower were of the attenuate type, like those of *B. betonicaefolia*, a nearly related species. A few hairs found only on the midrib below and near the petiolar attachment of a leaf of *B. Wislizeni* were found to be of the same kind. Gray (1853, p. 72) when describing *B. betonicaefolia*, four years after he had named *B. Wislizeni*, stated it was more closely related to the latter than

to any of the section which contains *B. Cavanillesii,* which is now *B. adenocarpa.*

With a complete representation of the genus, other such alliances might be found. Interest has already centered on several pairs or small groups of species which would make interesting test cases of this cyto-taxonomic approach.

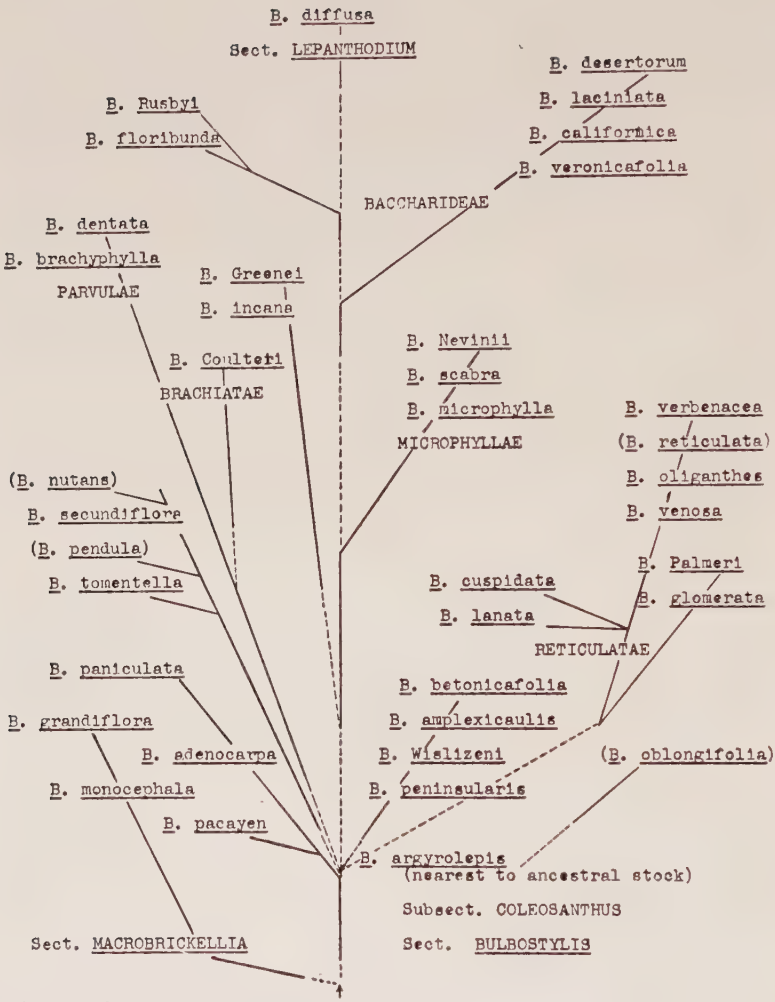
From a combination of taxonomic characters, along with the summarized items on karyotypic variations, an arrangement according to their probable evolutionary relationships has been attempted of those species studied (p. 336). To this end, the figures of the karyotypes were arranged in a somewhat similar order from 1 to 30, although the species have a reticulate rather than linear relationship. Four recently received species are included in figures 33, 34, 36, and 41.

From the discussion of what has seemed a somewhat artificial separation of some species from the subsection *Coleosanthus* to section *Eubrickellia* we would omit the latter, at least for those treated here.

SECTION MACROBRICKELLIA.

Because *B. monocephala,* with the largest heads, though primitive from several points of view, appears to show particular specialization, it is considered as a kind of sidebranch from an earlier ancestral stock. Along with it would be grouped what have been discussed as probably closely related species, though they are as yet unstudied cytologically: *B. hymenochlaena* and *B. simplex,* and in line with those, *B. grandiflora.* The three latter had been placed in *Eubrickellia* having the next largest heads. Their inclusion here would broaden this section, making it significant in relationships of root and leaf as well as similarity of heads and karyotypes.

It would hardly be justifiable to separate off the next from the above mentioned species of subsection *Coleosanthus,* although in their karyotypes a second pair of short chromosomes was more generally recognized. These include in a continuing link, the group of perennials such as *B. paniculata, B. secundiflora,* and *B. tomentella,* in which the type of trichome varies little in length of septation, *B. pendula* with glandular trichomes in addition, as has one variety of *secundiflora,* and the merely puberulent *B. nutanticeps.* All are from Mexico.



PHYLOGENITIC CHART OF SOME SPECIES OF BRICKELLIA

Figure 89

Those above have all had leaves of a somewhat broadened category. The limited material of the distinctively narrower leaved species with entire margins, *B. oblongifolia* var. *linifolia*, with a crowded plate of long chromosomes, would place it approximately in this position. However, no other species has

been studied that seems closely associated. With other narrow-leaved species unrepresented, such as the pair *B. pulcherrima* and *B. solidaginifolia* Gray, or *B. longifolia* Wats., and *B. multiflora* Kellogg, now remotely placed in sections II and V, respectively, this is one of the most poorly studied divergencies of the genus.

The two shrubs, *B. glomerata* and *B. hebecarpa*, if they are separate entities, placed by Robinson near the beginning of *Coleosanthus*, seem truly a connecting link with those above and the ones to follow. This is so, by foliar characteristics including venation and trichomes as well as karyotype. To them we would add *B. Palmeri*, which had been placed in the BACCHARIDEAE. Its karyotype was a complete misfit with the four others of that subsection examined, as was the coriaceous leaf. By this texture as well as the ovate leaf and the similarity of trichomes, it comes close to *B. glomerata* and *B. hebecarpa*. Its geographic range would appear to be a northward extension beyond Morelos, Guerrero, and Jalisco, where the other two occur, through Durango to Coahuila.

SECTION BULBOSTYLIS, SUBSECTION COLEOSANTHUS.

At the bottom, as the nearest present-day approach to the ancestral, would come the most woody *B. argyrolepis*, and shrubs like *B. pacayensis* and *B. adenocarpa*, with equally long chromosomes, in a somewhat broadened subsection *Coleosanthus* of section *Bulbostylis*. This would also include perennial herbs, previously in *Eubrickellia*, as *B. peninsularis* and *B. Wislizeni*, which by their karyotypes as well as technical characters would better come in a reticulate than linear arrangement. As well the two species, *B. amplexicaulis* and *B. betonicaefolia* would be associated along with the latter because of the similarities discussed above.

RETICULATAE. The connecting link referred to under the previous species, would bridge to the subsection *Reticulatae*, by which name the group is significantly differentiated. The leaves vary from linear- to lanceolate-oblong and have two submarginal veins strongly persistent to the tip which with smaller veins result in a somewhat arcuate venation. Those collected have in common a thick underground caudex which by its woodiness might merit an earlier position. It is erect, however, and not confused with the horizontal rhizomes of the first group.

Next to those studied, *B. venosa*, *B. oliganthes*, *B. reticulata* and *B. verbenacea*, and three other obviously similar ones already placed in this group, would be placed *B. cuspidata* and *B. lanata*. The broader, strongly reticulate leaves with distinct submarginal veins is a characteristic common to them both and not found as marked in others with non-entire margins. The narrower leaf of the one collection of *B. lanata* was no wider than seen in a larger leaf of *B. verbenacea*. It would be better expressed, though, to say that with these two, the previous members would be included as *Reticulatae*, since *B. lanata* with the larger heads and broader leaves would probably have been less advanced than those with smaller heads and narrower leaves. The karyotypes have been described above as being in good agreement. It will be noticed that by the inclusion of *B. cuspidata* here, and the previous disposition of *B. amplexicaulis* and *B. betonicaefolia*, along with *B. Wislizeni*, the subsection *Amplexicaules* has been stripped of all but one species, *B. subsessilis* Robinson. The one collection of it from Baja California has more rounded ovate leaves than *B. betonicaefolia* or *B. amplexicaulis*, but strongly resembles them in membranaceous texture and might be included with them.

Brachiatae. Though only *B. Coulteri*, one of eight species having petiolate triangular leaves, has been studied, there seems good reason to leave a group which is technically so similar. Robinson had provided in the key for possible confusion with *B. grandiflora*, but his separation has been well justified in the karyotype, as compared with at least *B. Coulteri*. In length, the chromosomes are smaller than *B. grandiflora* and very similar to those of *Reticulatae*, from which, however, one pair with satellites distinguishes them.

Microphyllae. Pending study of *B. Watsoni*, now in this group with *B. Nevinii*, *B. microphylla* and *B. scabra*, this group stands as one of small leaved, shrubby xerophytes and the karyotype seen in three of them is that of the so-called general.

Incana. Because the strictly desert form, *B. incana*, of extremely isolated distribution in southern California and Nevada, has an individual tomentum of long, thin-walled, almost unseptate trichomes, of which a few have side branches, this species stands by itself. This was thought to be true of its karyotype as

well as the very large achene. After receiving a complete specimen of *B. Greenei*, it was found to compare with *B. incana* as follows: Both were perennial herbs, though the base of *B. incana* was described as woody; leaves were ovate rather than ovate-orbicular and very short petiolate rather than sessile; both had heads ca. 60-flowered, terminating branches of a subcorymbose inflorescence and the achenes were 7 and 10 mm. long. The distinctive characters of *B. Greenei* were the long, outer, herbaceous phyllaries, which like the stem and leaves were covered with the biseriate glandular trichome in contrast to the long non-glandular. Thus they differed in their types of pubescence just as the otherwise closely related members of the subsection MICROPHYLLAE. Since the biseriate glandular organ is present in the leaves of other species either elevated as a trichome or depressed in the punctate condition, the differences in technical characters were not great. The two species appear to be more closely related than either approaches any other. Both are xerophytes, restricted to different areas. The similarity of their karyotypes bears out their juxtaposition in the chart.

PARVULAE. With the appearance of slightly shorter chromosomes in *B. dentata*, the evolutionary trend of reduction seems to have begun by an overall shortening. Of the perennial herbs of somewhat lanceolate leaves, belonging to the subsection *Parvulae*, only the two, *B. brachyphylla* and *B. dentata*, have come under investigation. From the karyotype, as well as unusually delicate trichomes contributing the puberulence of *B. dentata*, it may be that a distinctive line of evolution is indicated which the study of other species would confirm.

BACCHARIDEAE. The more discussed species, *B. veronicaefolia*, *B. californica*, *B. desertorum*, and *B. laciniata*, assembled in this group by the taxonomist, will not differ too much now from other subsections in having represented species of 18 to 62, 8 to 18, 8 to 12 and 9 flowers, respectively. The soundness of his judgment in placing together four species which have been found to have such similar karyotypes, yet so distinctive from the majority, as well as the more moniliform trichomes and small achenes, is another proof of the great genius of Robinson.

FLORIBUNDA AND RUSBYI. The karyotypes of *B. floribunda* and *B. Rusbyi* suggest a close relationship of these two species.

It is notable that Gray (1884), when describing *B. Rusbyi*, spoke of its having the habit of *B. floribunda*, except that the inflorescence was thyrsoid paniculate whereas that of the latter had been described as a corymb of many heads. The leaves of both are given as alternate, deltoid- or rhombic-ovate. That *B. floribunda* has glandular trichomes, and the other sessile glands and attenuate trichomes, is not more different than has been found within varieties of the same species. For in *B. adenocarpa*, *B. secundiflora*, and *B. Palmeri*, having so-called glandular and non-glandular varieties, the latter still have the sessile glands. Heads are of the same size, being given as 16- and ca. 15-flowered. The achenes of both are small. Gray had described both as herbaceous. Robinson's adjective "suffrutescens," for *B. floribunda* suggests a tendency to the shrubby. It is evidently a little stronger, and a little taller, up to 1.5 meters in contrast to 1 meter, and has, as well, a more ample inflorescence than *B. Rusbyi*.

These two species had been placed as the first and the last of subsection *Coleosanthus*, characterized by larger petiolate leaves than the previous subsection *Baccharideae*. As the latter are shrubby xerophytes, the two perennials hardly fit in there any better than they do with the otherwise entirely Mexican and Guatemalan species of *Coleosanthus*. Yet the karyotypes of *B. floribunda* and *B. Rusbyi* resemble strikingly those of two of the *Baccharideae*, *B. californica* and *B. laciniata*. The two perennials are cohabitants with *B. californica* as can be seen by the sources of accessions in table I. All three have been studied from the same county, Pima, Arizona, and two of them, *B. californica* and *B. Rusbyi*, from the same county in New Mexico, Cochise. While *B. floribunda* has only glandular trichomes, on *B. Rusbyi* the same moniliform type was found as in *B. californica* and *B. laciniata*. It would seem that in these two herbaceous perennials evolution had taken another step ahead. Perhaps from a common earlier form, which had already acquired the karyotype of reduced chromosome size, there was a divergence from the shrub to the perennial. There is no place in the genus, among the species studied, where the parallelism of karyotype with perennial and shrub is as evident. Yet the genus consists largely of both these growth-forms and it must have taken place many times.

For the present we have placed them by themselves on a side branch next to the *Baccharideae*.

SECTION LEPTANTHODIUM. The two species just discussed suggest an even more exciting stepping stone to the few annuals occurring in this genus. Though there is only the one well-known and widely spreading species, *B. diffusa*, Robinson described a second, *B. filipes*, from limited material of two locations and from specimens lacking the base. He placed it in this section pending confirmation of the root, because of similarity to *B. diffusa*. Both have broad ovate leaves and heads of 8 and 14 flowers, with the new species varying in clavellate rather than the filiform style, which is singular to the whole genus. From examination of the pappus these two have equally delicate pappus setae, on which the barbules are arranged tristichously rather than somewhat distichously as in the majority of species. It is obvious that there have been many gene changes in the major break from perennial to annual. However, the karyotype of *B. diffusa*, with short chromosomes, finds a close approach in those of the two perennials, and the shrubs with which the comparisons are here made.

Summary

The chromosome number was obtained in 41 species of *Brickellia*, representing the genus fairly well geographically as well as sectionally. Although some species occur well into the tropics they are limited to the plateaus, except the annual *B. diffusa*, and thus really grow under temperate rather than tropical conditions. In this study about equal numbers of shrubs and herbaceous perennials were included as well as one annual. Since all had $2n = 18$, no correlation of chromosome number with the amount of woodiness was found in this genus.

Meiotic divisions were examined in 21 of the species plus varieties. In 4 plants, representing as many species, out of a total of 26 accessions, irregularities were found usually associated with structural hybridity. These included lagging chromosomes at I metaphase and chromosome bridges and fragments on I telophase spindles, characteristic of inversions. The irregularities were found in Mexican species, three of them belonging to subsection *Coleosanthus*, where intermediates have been recog-

nized. The irregular meiosis of the fourth species, *B. reticulata*, offered a strong contrast to the regular seen in three other closely related species. This does distinguish it from another species from which it has been considered doubtfully distinct.

Somatic divisions were seen in 71 accessions representing 39 species. In 33 perennial herbs and shrubs and the one annual, the karyotypes were studied with especial care and compared. One chromosomal complement, or a complement so closely approaching it that it could not be distinguished, consisting of long, medium and short chromosomes, was common to 14 perennial species. Since so many species had a similar general karyotype, genic changes must be largely responsible for speciation.

Evidence was found for considerable reduction in the length of the chromosomes in a minority of species and this is believed to mark a major trend in the evolution of the genus. In one species there was a tendency for all of the chromosomes to be shorter than in the general type. Eight species had no chromosomes longer than those of the medium class but had in addition other unusually short ones. The one annual had a karyotype somewhat similar to these. In contrast to these nine species in which the karyotypes had a smaller than average amount of chromatin, there was evidence in eight species for a greater than average total of chromatin material. The karyotypes of two species consisted only of long and medium chromosomes and in six others there was only one pair of short chromosomes, rather than two pairs.

No direct evidence was obtained which would explain the great variation in length of the chromosomes, although there were indications of possible loss of small segments.

Only three species were found to have a pair of satellite chromosomes, one having an otherwise general karyotype and the other two, a karyotype with short chromosomes. Generally there was a lack of evidence of increasing asymmetry of chromosome structure with advancing evolution.

Since the single annual has short chromosomes, there appears to be a parallelism between the reduction of chromosome size and the length of life cycle. Others with short chromosomes included four herbaceous perennials and four of subsection *Baccharideae*, consisting of shrubby xerophytes. The karyotype

with the longest chromosomes was found in a small group of perennials with exceptional fleshy rhizomes which suggest specialization. Among those with karyotypes next greatest in chromatin content were shrubby species, of which one is probably the largest and the most woody of the genus. This may be the nearest present day approach to the ancestral type.

Although the correlation is not complete, along with the trend to reduction in length of life cycle and chromosome size, goes a somewhat parallel reduction in achene size. At least, the species which have the longest chromosomes are among those having the largest achenes and those which have short chromosomes are, with two exceptions, among those having the smallest seeds. The shortest of all achenes were found in the annual species and these too, proved to have the greatest longevity of any of those tested. To a considerable extent there has also been a correlation between reduction of the number of florets per head and size of plant, but there are exceptions.

From a microscopic examination of leaves of species thought to be similar in other technical characters, additional support of relationship was found in the similarity of their trichomes. Also, several instances of correlation were found between the kind of trichomes and the chromosomal complements of the species. For example, the same moniliform type of trichome which occurred on species of the *Baccharideae*, having short chromosomes, was also found on one of the two perennial species with a similar karyotype, the other perennial having no non-glandular trichomes. Furthermore, *B. Palmeri*, which was found to have a karyotype unlike the other species of the *Baccharideae*, did not have a moniliform trichome. Instead, it was similar to that of another species and thus strengthened the inclusion of *B. Palmeri* with that species in a different subsection

The development of the larger glandular trichome, seen in some species and varieties by macroscopic observation, was traced from the depressed glands which are very characteristic of the genus.

This glandular trichome on a stalk of biseriate cells is but an expression of the outgrowth of the depressed gland, consequently no correlations were found with specific karyotypes.

Finally from a combination of taxonomic characters and karyo-

typic variations an attempt was made to arrange the species studied according to their probable evolutionary relationships (see chart, fig. 89).

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A New Color Form of Triosteum angustifolium.—In the process of monographing the caprifoliaceous genus *Triosteum*, the author was somewhat puzzled by two specimens resembling *Triosteum angustifolium* L. collected by Dr. C. C. Deam 797, May 13, 1906, from Franklin County, Indiana. They were labeled *Triosteum aurantiacum* Bicknell, but the hispid-ciliate sepals, the long bracts, the strigose upper leaf surface, the leaf-shape, and the general character of the plant indicates that it is not *Triosteum aurantiacum*. Later while examining specimens from Missouri, two more sheets resembling *Triosteum angustifolium* were found labeled *Triosteum aurantiacum* with a note that the flowers were orange. The plants were collected May 9, 1913, on rich hillsides, Jerome, Phelps County, Missouri, by John H. Kellogg.

On April 26, 1953, in a woodland near Karnak, Pulaski County, southern Illinois, three plants of a red-flowered *Triosteum* were discovered growing within a few feet of the typical lemon-yellow-flowered plants. Two of these plants were collected, one deposited in the herbarium of the University of Illinois and the other planted in a yard at Urbana, Illinois. Further search of the woods at this date and again on May 9, 1953, revealed no other red-flowered plants. The typical *Triosteum angustifolium* was scattered throughout the red oak and hickory woods in rich leaf mold.

A careful comparison of the typical form with the red-flowered form showed no differences other than the flower color except that the general habit of the red-flowered form is more robust. Herbarium specimens of *Triosteum angustifolium* from other localities, however, match the red-flowered form in size and general appearance. The red-flowered specimens from Indiana are almost identical in size and shape with yellow-flowered specimens collected by Dr. C. C. Deam in the same locality, but on different dates. The color of the corolla is near jasper red according to Plate XIII of Ridgway's *Color Standards and Color Nomenclature;* it is much lighter than the reddish-purple that occurs in the other species and varieties of *Triosteum*. The possibility of a hybrid seems unlikely because no other species or varieties of *Triosteum* were found in the area.

It is interesting to speculate whether this is the *Triosteum hispidum* that Rafinesque described from Kentucky in 1836.

His description reads: "stem flexuose striate hispid, leaves sessile ovate spatulate acuminate smooth ciliolate, axils uniflore, flowers sessile, ovary hispid, calix smooth linear lanceolate—in the glades of West Kentucky with the last, [*Triosteum angustifolium*] but quite distinct by broader smooth leaves quite sessile, corol orange color." The sepals in the red-flowered form discussed above are hispid-ciliate on the margin exactly as those of *Triosteum angustifolium*, but Rafinesque omits this character in describing both *Triosteum hispidum* and *Triosteum angustifolium*. The label-data on the specimens from Missouri indicate that the corolla was orange as Rafinesque states for *Triosteum hispidum*, but the plants from Karnak (Illinois) have flowers that are more nearly red than orange. Rafinesque further states that the leaves of *Triosteum angustifolium* are slightly scabrous and the leaves of *Triosteum hispidum* smooth. I am not able to verify either of these characters in the specimens I have examined. Although the description of *Triosteum hispidum* varies slightly from the modern specimens examined, it seems probable that this red-flowered plant is the same thing that Rafinesque attempted to describe.

From an examination of 160 sheets of *Triosteum angustifolium* and about 600 sheets of other species and varieties of *Triosteum* only five specimens of this red-flowered plant were discovered. Fruiting specimens examined in July show no difference in the color, shape, or pubescence of the fruit. It is, therefore, proposed to treat this plant as a form of *Triosteum angustifolium*. This is the first flower-color form that has been described in the genus.

Triosteum angustifolium L., forma **rubrum** Lane, f. nov.—Haec forma a planta typica speciei corollis rubris recedit.

This form differs from the typical form of the species in having red corollas.—Growing near *Triosteum angustifolium* L. under a cover of *Quercus rubra* and *Carya ovata*, ½ mile west of Karnak, Pulaski County, Illinois, April 26, 1953, *Franklin C. Lane*, 1441, TYPE in Herbarium of University of Illinois, Urbana, Illinois.—Franklin C. Lane, department of botany, university of illinois, urbana, illinois.

Two Unusual Plants in Essex County, Massachusetts.—In mid-July I found a number of plants of a *Verbascum* which seemed different from any that I had seen before. Some of the plants had yellow petals and some had white ones but otherwise they were similar. An outstanding characteristic was the dark red, almost mahogany-colored, beard on the filaments. These plants appeared in recently seeded ground near a new school house in Lynn not far from the Lynnfield line. The plants did not seem to fit into any of the species described in Gray's Manual. A search in the Herbarium of the New England Botanical Club resulted in the identification of the plants as *Verbascum nigrum* L., a species not included in the Gray's Manual. In the New England Botanical Club Herbarium there are only three specimens of this species, two from Jefferson, Coös County, New Hampshire and one from Milton, Norfolk County, Massachusetts. On the label of the Milton specimen collected in 1919 is the significant note added, "Flowers yellow, sometimes white." In the Gray Herbarium this species is represented by a number of specimens from European stations all the way from Sweden to the Alps.

An unusual *Geranium* appeared in July in the perennial garden of Mr. Charles C. Stockman of Newburyport, Massachusetts. This proves to be *Geranium nepalense* Sweet, var. *Thunbergii* (Siebold & Zucc.) Kudo which was reported for the first time in America by Mr. F. W. Hunnewell from Wellesley in 1945 (Rhodora 47: 219). However in Gray's Manual in the description the petals are given as violet while in this recent specimen the petals are definitely white with violet lines. Reference to the Herbarium specimens for petal-color was unsatisfactory as the dried petals had faded and no notation was given on the labels as to the original color. This is a Japanese variety of an Asiatic species.—Ralph C. Bean, wakefield, massachusetts.

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